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Preliminary evaluation of new cable restraints to capture coyotes

John A. Shivik, Kenneth S. Gruver, and Thomas J. DeLiberto

Abstract The need for alternative predator capture techniques is increasing, but currently available and tested animal capture technology is limited. To evaluate recently developed devices, we conducted a field study of 4 new types of coyote (*Canis latrans*) capture and restraint systems. We tested the Belisle®, Panda®, Collarum®, and the Wildlife Services systems to capture coyotes in south Texas during February 1998 and February 1999. We designed field work to determine capture efficiency and selectivity and performed whole-body necropsies to identify trap-related injuries. Results showed a final capture rate (coyote capture per capture opportunity) of 78% for the Belisle, 8.3% for the Panda, 41% for the Collarum, and 66% for the Wildlife Services system. Some of these prototype systems may cause fewer injuries than traditional capture methods but may not be as efficient as jawed traps. To meet or exceed guidelines of recently established international standards for humane trapping, 80% of captured animals cannot show injury indicators of poor welfare, but the Belisle, Wildlife Services, and Collarum devices did not cross this threshold (31%, 40%, 70%, respectively, did not show any indicators). We were not able to capture enough animals with the Panda to thoroughly evaluate the device for selectivity and injury. However, simple modifications and improvements are ongoing and are likely to result in versions of these devices with improved efficiency and fewer indicators of injury.

Key words *Canis latrans,* coyote, snares, injury, trap

Steel-jaw foothold traps are commonly used tools to capture coyotes (*Canis latrans*) for fur, biological research, and for depredation and population management. In recent years, the concern that these devices may inflict unnecessary injury to trapped animals has led to the restriction and loss of jawed foothold traps in some areas of the United States (Cockrell 1999). Capture devices also are of international concern, as indicated by international agreements ratified by Canada and the European Community and currently proposed for ratification in Russia. The United States is party to the standards set forth in the form of a nonbinding Agreed Minute which stipulates acceptable thresholds for injury of captured animals (United States of America-European Community 1997). These recent international agreements highlight the need to monitor newly developing capture systems relative to accepted animal injury standards.

Continuing international interest in capture-systems technology (Andelt et al. 1999) has promoted recent testing of traditional (Onderka et al. 1990, Skinner and Todd 1990, Phillips et al. 1992,), padded (Linhart and Dasch 1992, Phillips and Mullis 1996, Phillips et al. 1996), and otherwise modified traps (Houben et al. 1993, Gruver et al. 1996, Hubert et al. 1997) and snares (Phillips 1996). Stringent regulations have limited the use of traditional steel-jaw devices, and the types of injuries associated with jawed traps are likely to preclude some models from achieving international injury-rate thresholds. However, powered cable restraining devices, which

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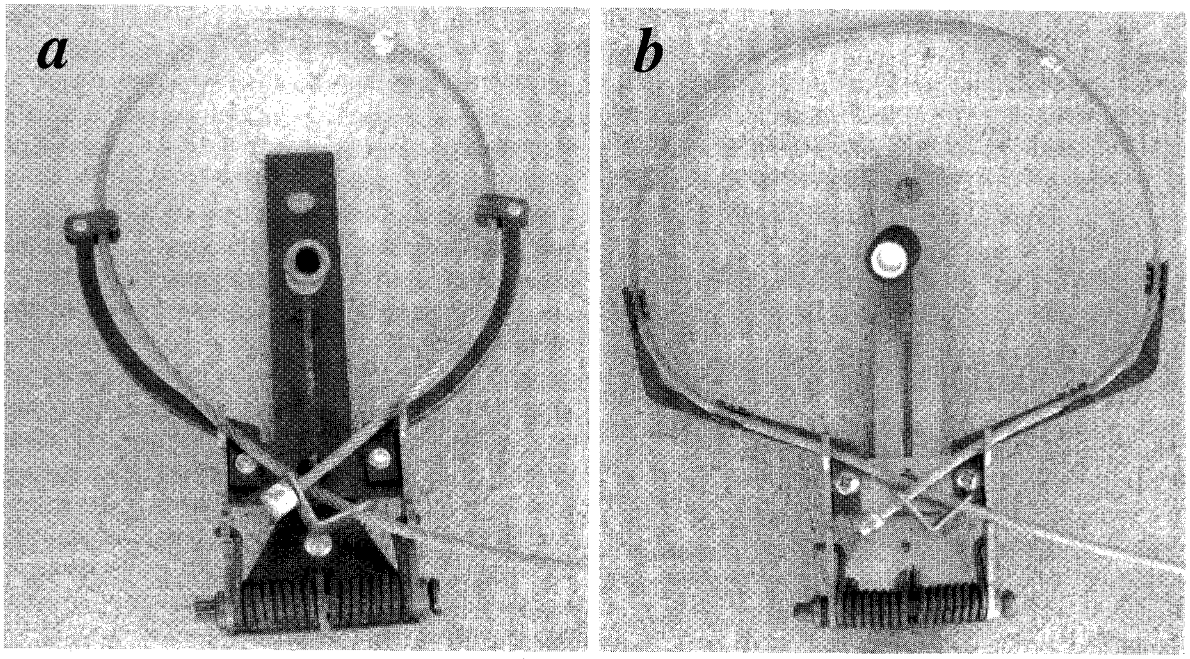

Figure 1. Collarum® Neck Restraint produced by Green Mountain Inc. (Lander, Wyo.): (*a*) initial prototype tested in 1998; (*b*) modified version tested in 1999.

grip with a restraining cable rather than a steel jaw, may be used where steel-jaw devices are restricted and have the potential to reduce animal injury. New cable restraining devices are being developed and are beginning to be marketed, but little is known about their efficiency, injury rates, and selectivity. The objective of our research was to evaluate 4 newly developed coyote capture systems.

Methods

We tested 4 types of cable restraining devices on coyotes in field situations during 2 studies on private land in Webb County, Texas. In this paper, we use the commercial names of products for identification only and not as an endorsement of products by the authors or the United States Department of Agriculture. The initial study included the Collarum restraint (Green Mountain Inc., Lander, Wyo.; Figure 1*a*), which uses a baited pull-tab that triggers a pair of coil-spring-powered throw-arms. The paired throw-arms carry a 0.476-mm (3/16") cable loop over the head and onto the neck of a coyote. When the coyote recoils away from the triggered device, the cable loop tightens around its neck. Via a stop attached to the cable, the coyote is held as if restrained with a leash and collar and is not choked.

The Panda Footsnare (Green Mountain Inc., Lander, Wyo.; Figure 2) is a hybrid chain-loop device similar to a coil-spring foothold trap. When the pan is depressed, the coil springs power a chain loop up and around the foot of a coyote. A throw-arm bar is designed to push the coyote's leg into the chain loop, where it is restrained.

The Collarum and Panda devices were tested during February 1998 on ranches in Webb County, Texas. Because these devices were novel to trappers, we made an *a priori* decision to allow one week of trapping before beginning data collection so that field personnel could become familiar with each device. We established traplines along unimproved ranch roads and checked traps during the morning; it is unlikely that any animal was restrained for more than 24 hours. Trappers (K. S. Gruver and a technician trained by Gruver) chose trap sites based on their experience and coyote spoor in the area, but they randomly selected restraining devices for placement at a chosen trap site.

To measure capture rate (efficiency) of each device, we divided number of coyote captures/device by number of potential captures; a potential capture occurred when a coyote triggered the trap and was caught but then escaped or was caught and held (Phillips et al. 1992). Trappers examined

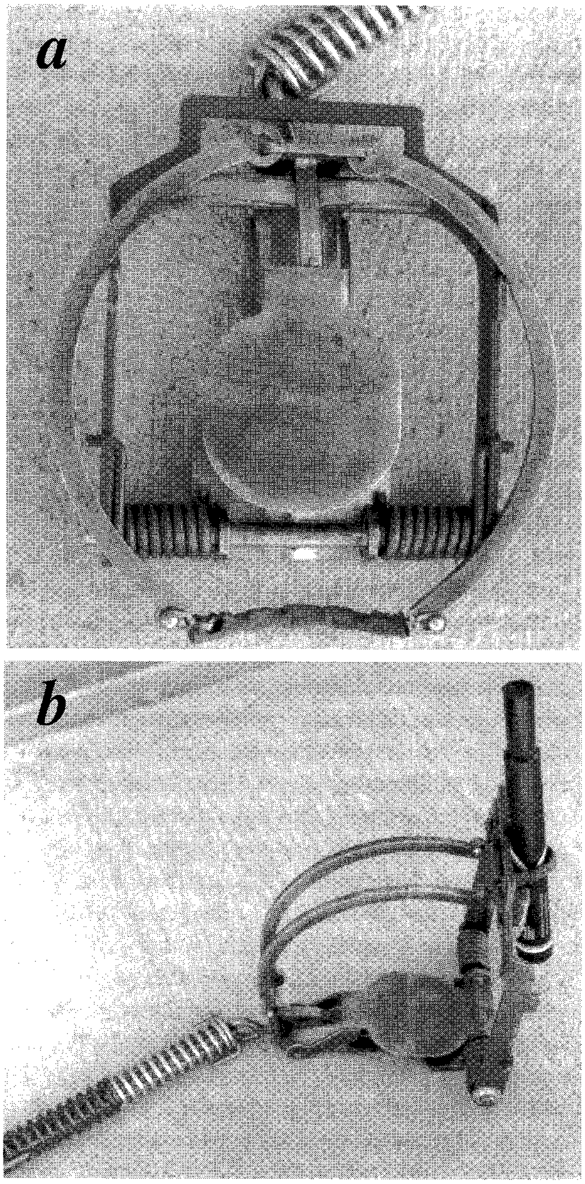

Figure 2. Panda® Footsnare developed by E. E. Lee (Green Mountain Inc.): (*a*) set; (*b*) in the restraining configuration.

tracks and sign at the site to identify potential captures. We defined selectivity as the percentage of coyotes captured relative to total number of animals captured, and we examined injury using full body necropsies. Trappers euthanized captured animals with a gunshot to the head and immediately froze the carcasses. Due to the logistical constraints of shipment, not all carcasses collected were necropsied (carcasses were selected randomly for necropsy). Carcasses collected during this study were shipped to the University of Wyoming, where whole-body necropsies were performed by

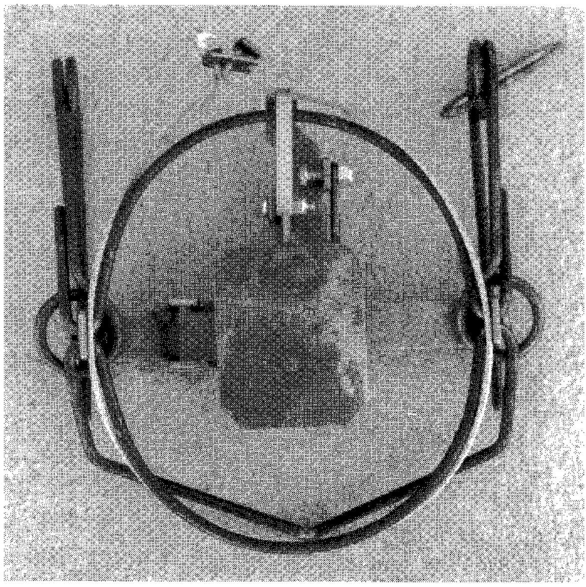
Figure 3. The Belisle® device manufactured by Edouard Belisle, Sainte-Veronique, Quebec, Canada.

a veterinary pathologist. The veterinarian necropsied coyotes by skinning and examining the entire animal for injury (United States of America–European Community 1997, International Organization for Standardization 1999).

We performed a secondary study during February 1999 to test a new model of Collarum restraint (modified with wider throw-arms and stronger springs, Figure 1*b*), the Wildlife Services (WS) system (developed by WS specialists in the western United States, Figure 4), and the Belisle system (Figure 3). The WS device uses a coil spring and a throw-arm to deliver a 0.125-mm (1/8") cable up around the leg of a coyote. When the pan is depressed, the throw arm simultaneously pulls the loop up and draws it closed. The Belisle (Edouard Belisle, Sainte-Veronique, Quebec) consists of a throwing device similar to a coil-spring foothold trap. This device, however, incorporates breakaway springs and a 0.125-mm (1/8") steel cable with a one-way lock formed into a loop and held over the frame loops. When triggered, the frame loops clamp onto the coyote's leg and place the snare cable up and around the leg. As the coyote pulls away from the device, the cable tightens and restrains the limb. Struggle engages the breakaway springs, which causes the jawed throwing device to fall free. A veterinarian (trained to use identical methods by the veterinary pathologist used in the first study) performed whole-body necropsies at the National Wildlife Research Center, Fort Collins, Colorado.

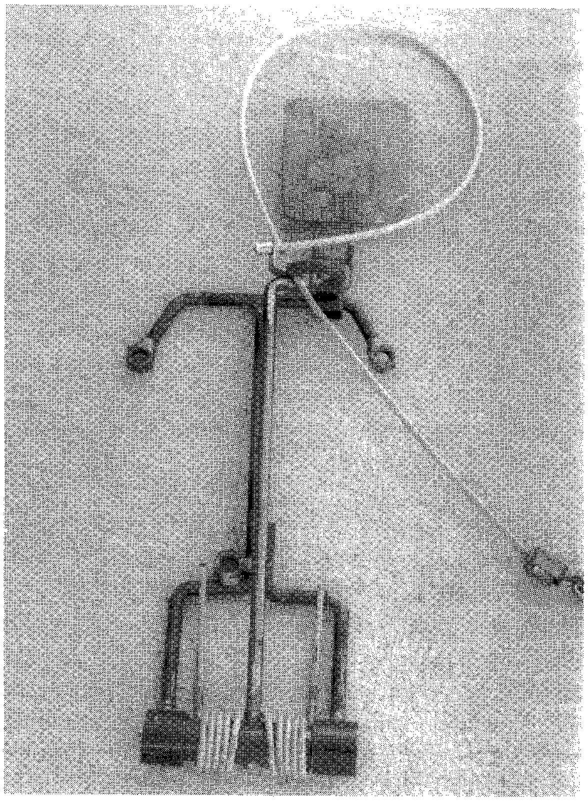

Figure 4. The restraint device developed by Wildlife Services specialists in the western United States.

Veterinarians had no knowledge of the capture systems used, and the whole-body necropsies (Hubert et al. 1997) were performed in accordance with international agreements and recommendations (United States of America-European Community 1997, International Organization for Standardization 1999). We evaluated capture-system injury according to established thresholds. Specifically, indicators of poor animal welfare encompassed the following categories of injury: Fracture, joint luxation proximal to the carpus or tarsus, severance of a tendon or ligament, major periosteal abrasion, severe external hemorrhage or hemorrhage into an internal cavity, major skeletal muscle degeneration, limb ischemia, fracture of a permanent tooth exposing pulp cavity, ocular damage including corneal laceration, spinal cord injury, severe internal organ damage, myocardial degeneration, amputation, or death. According to the guidelines for humane trapping, a device is considered to exceed the standard if ≥80% of a sample of 20 captured animals show none of these indicators.

Results

We captured 16 coyotes in the Collarum restraint during the initial study. Five more coyotes freed themselves and 20 Collarums were sprung with no captures (capture rate=39%, SE=7.7%). This device captured no animals other than coyotes. Some of the coyotes captured with the Collarum had slight edema and swelling of the head and neck, 3 sustained tooth damage, and one lost a tooth, resulting in 75% without indicators of poor welfare (SE=11%, Table 1).

The Panda captured only one coyote during the initial study. However, 9 coyotes were able to free themselves after apparently being captured and 2 coyotes sprung the devices without being restrained (capture rate=08.3%, SE=8.2%). This device did not capture any other species. The only injury suffered by the single captured animal was mild edema around the restrained limb and the fracture of one tooth, exposing the pulp cavity.

In the secondary study, we captured 38 coyotes using the Belisle, with 11 misses or escapes (capture rate=78%, SE=6.0%). We captured 6 non-coyote species, including 3 bobcats (*Lynx rufus*), one caracara (*Polyborus plancus*), 8 raccoons (*Procyon lotor*), one gray fox (*Urocyon cinereoargenteus*), 2 rabbits (*Sylvilagus* spp.), and one badger (*Taxidea taxus*), resulting in 70% selectivity for this device (SE=6%). Due to freezer size and transportation limitations, only 16 (randomly chosen) coyotes captured in the Belisle were retained for necropsies. Among these, the major injuries included edematous swelling and hemorrhage, cutaneous lacerations, minor subcutaneous soft-tissue maceration and erosion, minor periosteal abrasions, permanent tooth fractures, and chipped teeth (Table 1). Only 31% (SE=12.0%) of coyotes were without indicators of poor welfare.

The Collarum Neck Restraint captured 29 coyotes during the secondary study but allowed 41 misses or escapes (capture rate=41%, SE=6.0%). This device captured coyotes exclusively. The major injuries produced were chipped teeth, tooth fractures, edematous swelling or hemorrhages, and one death from a failure of the stop on the snare cable (Table 1). Due to freezer size and transportation limitations, only 24 (randomly chosen) coyotes captured in the Collarum were retained for necropsies. Four coyotes sustained no detectable injury, and 70% (SE = 9.0%) of the captured animals showed no indicators of poor welfare.

Table 1. Injury data from whole-body necropsies of coyotes taken with restraining devices during studies in Webb County, Texas, 1998–1999.

Injury	Collarum® 1998 $n=16$ No.	%	Belisle® $n=16$ No.	%	Collarum® 1999 $n=24$ No.	%	WS $n=20$ No.	%
No injury	0	0	1	6	4	17	0	0
Claw loss	2	12	0	0	0	0	0	0
Edematous swelling or hemorrhage	7	58	14	88	4	17	17	85
Cutaneous laceration	0	0	11	69	2	8	13	65
Laceration on foot pads or tongues	0	0	0	0	0	0	2	10
Minor (below carpus–tarsus) subcutaneous soft-tissue maceration erosion	0	0	9	38	1	4	11	55
Major (above carpus–tarsus) subcutaneous soft-tissue maceration erosion	0	0	1	6	0	0	0	0
Minor periosteal abrasion	0	0	7	44	0	0	6	30
Major periosteal abrasion	0	0	4	25	0	0	6	30
Severance of (below carpus–tarsus) tendon or ligament	0	0	4	25	1	4	2	10
Compound or comminuted fracture at or below the carpus or tarsus	0	0	1	6	0	0	0	0
Permanent tooth fracture exposing pulp cavity	4[a]	25	6	40	5	21	9	45
Chipped tooth, not exposing pulp cavity	0	0	12	75	16	67	18	90
Tooth fracture exposing pulp cavity (old)	0	0	3	19	3	13	1	5
Death	0	0	0	0	1	4	0	0

[a] Includes 3 fractures and one tooth loss.

The WS device captured 23 coyotes but had 12 misses or escapes (capture rate=66 %, SE=8.0%). Seven noncoyote species were captured including 2 badgers, 2 feral pigs, one deer (*Odocoileus virginianus*), 2 raccoons, one javelina (*Tasyassu tajacu*), one domestic dog, and one bobcat (selectivity=70%, SE=9.8%). Due to freezer size and transportation limitations, only 20 (randomly chosen) coyotes captured in the WS device were retained for necropsies. Injuries from this snare included edematous swelling and hemorrhage, cutaneous lacerations, minor subcutaneous soft-tissue maceration and erosion, permanent tooth fractures, and chipped teeth (Table 1). Forty percent (SE=10%) of the captured animals showed none of the indicators of poor welfare.

Discussion

Capture rate

In this study, the devices that had the greatest capture rates tended also to be the least selective and to cause the most injury to restrained animals (Figure 5). However, none of the devices tested appeared to be as efficient as traditional jaw-type capture systems. Capture rates of 95%, 95%, 89%, and 100% were found in 7 western states using the Victor No. 3 NM, Victor No. 3 Soft Catch, Newhouse No. 4, and the Sterling MJ 600, respectively (Phillips and Mullis 1996).

The capture rate using the Belisle approached that reported for jawed traps, and a major benefit of the Belisle is its similarity to a coil-spring trap regarding setting procedures and usage. One coyote was captured in the Panda during this study; however, we recorded 11 pullouts and misses. Based on our own observations using captive coyotes (K. S. Gruver, unpublished data), the escapes are likely the result of weak spring tension. The holding force of the device may possibly be corrected by greatly increasing spring pressure so that it would successfully clamp and hold captured coyotes. The Collarum restraint captured 16 coyotes

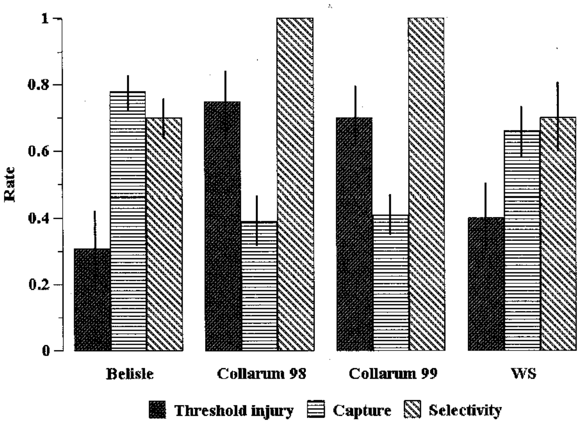

Figure 5. Threshold injury rate (i.e., percentage of animals not showing any of the established indicators of poor welfare—see text), capture rate (captures per opportunity), and selectivity rate (number of coyotes captured/total number of animals of all species captured) of devices tested during 1998 and 1999 in Webb County, Texas. Error bars represent one standard error.

during the initial study, but the capture rate was relatively low. The device is very directional and is not likely to capture an animal that does not approach and pull the triggering mechanism from directly in front of the device. Based on our field results and our observations of device action in pen trials, we believe that many of the sprung and empty Collarums were the result of coyotes activating the device from one side or coyotes ducking away rather than jumping up after the device was triggered (thus slipping out beneath the snare loop). Although capture rates were relatively low for the version of the device we tested, modifications have been made that include attachment of a secondary throw-arm which automatically draws the snare loop tight once the throw-arms have thrown the snare loop over the coyote's head (E. E. Lee, Green Mountain Incorporated, personal communication). This modification should prevent failed captures that result from coyotes ducking away from the cable, and may allow use of wide loops to assist with captures of animals that do not approach the device directly.

The WS snare had a capture rate of 66% for coyotes. We believe that the large throw-arm device may work well for larger animals such as bears (*Ursus* spp.), mountain lions (*Felis concolor*), and wolves (*Canis lupus*). However, a smaller, more refined triggering system that would allow for pan tension adjustment and a smaller throw-arm might increase coyote capture rate and ease of use.

Injury

It is difficult to use injury scores to compare differences in injury between these devices and others because injury scales have only recently been standardized using whole-body necropsies (International Organization for Standardization 1999) and are inappropriate for statistical comparison (Engeman et al. 1997), and because previous injury scores do not address tooth and other whole-body injuries. However, because of the ubiquitous use of injury scores in the literature, we have included some discussion of them here for a general comparison of these devices to other traps. Using the method set forth by Olsen et al. (1986), the mean injury scores from the devices we tested were 0.94, 20.93, 2.29, and 12.75 for the Collarum 1998, Belisle, Collarum 1999, and WS devices, respectively. For comparison, Olsen et al. (1986) reported mean scores from 3.0 for controls to 96.9 for unpadded traps and 28.6–50.2 for padded traps. Using the scoring method adapted by Phillips et al. (1996), the mean injury scores for the devices tested in this study were 4.4, 46.6, 4.4, and 12.3 for the Collarum 1998, Belisle, Collarum 1999, and WS devices, respectively. Phillips et al. (1996) reported mean trauma scores of 103.3 for an unpadded trap and 29.0 and 79.3 for 2 padded traps. Using the method of Onderka et al. (1990) as modified by Hubert et al. (1997), scores were 2.5, 35.6, 5.4, and 22.5 for the Collarum 1998, Belisle, Collarum 1999, and WS devices, respectively; with the same scale, Hubert found a standard coil spring to register a mean injury score of 97 and the same trap modified with offset jaws and lamination to be 80. Using ISO standards, which incorporate a much broader array of injuries, including those to teeth (International Organization for Standardization 1998), injuries caused by devices tested in this study scored 9.93, 50.9, 13.5, and 42.0 for the Collarum 1998, Belisle, Collarum 1999, and WS devices, respectively.

Cable restraints in their current form do not wholly prevent injury and further research and development is still required. Most injuries from the Belisle system involved cable-caused swelling and small lacerations on the legs of captured coyotes, although we observed one bone fracture. Fractured and chipped teeth occurred frequently, probably from animals chewing on the restraining cable. The Belisle cable incorporated a short sheath of tubing which may have prevented some lacerations, but because the unsheathed cable used by the WS system also caused lacerations, the application of rubber-sheathed tubing is not sufficient for eliminating injury caused by cables and locks. We suggest that frequency of broken teeth may be reduced by attaching a rubber tab to the lock end of the cable that would allow a coyote to perform displacement behaviors, such as chewing, without causing tooth injury.

With the modified Collarum system, 17% of coyotes had no detectable injuries, and it is apparent that this device caused much less injury than limb restraints. The most significant injuries were tooth damage, probably caused by chewing on the restraining cable. If tooth damage could be prevented, the device would probably be acceptable according to established injury thresholds. Again, a coated cable, or a displacement-behavior "pacifier" attached to the lock end of a cable, may prevent this type of injury.

The WS device produced injuries that were similar to those from other leg snares (Onderka et al.

1990). As with other restraining cable systems, we believe that tooth and other injuries associated with this device might be reduced by using a soft coating on the restraining cable or a chew-tab on the stop-end of the snare cable. It also is likely that using a larger-diameter cable or a beaded cable (i.e., rubber beads on a constricted cable loop) might prevent cutting and allow circulation to be maintained to the limb and might decrease injury to an animal's restrained leg.

Selectivity

The Belisle device was selective, with 70% of the animals captured being coyotes. The WS system was also 70% selective. Skinner and Todd (1990) reported an overall selectivity of 58% for the devices they tested. The Collarum was particularly selective for coyotes (100%). The baited top and capture mechanism are relatively species-specific, and the mechanics of the device make capture of other species very unlikely.

Implications for use

Inferences from our tests were limited for 2 reasons: first, we set in only one geographical area (Texas) with relatively warm temperatures and sandy soil. Setting these devices in wet, freezing, or dense and resistant soils, for instance, might require adding more powerful springs or stiffer cables, or using dry, sandy bedding to achieve similar capture efficiencies. Second, the devices are currently under development and are likely to be improved and changed because of our testing. Because of the current evolution of these devices, we did not attempt to certify them against human trapping standards set forth in the Agreed Minute (United States of America-European Community 1997), but our results indicate that none of them would pass the rigorous standards without modifications.

The Panda hybrid system was very inefficient and we were not able to thoroughly evaluate it for selectivity and injury, but the cable restraint systems that we tested showed potential for successfully capturing coyotes while avoiding injuries. Overall, the Collarum was particularly selective for coyotes and had the lowest injury rates, but its inefficiency will limit its usefulness in many management situations. However, it may be possible to make modifications in design and setting techniques that would increase capture rates to a more acceptable level prior to field use. The applicability of a particular capture system is dependent upon the context of its application, and choosing a system is a matter of optimizing capture efficiency while minimizing animal injury, superfluous species capture, cost, safety, and difficulty of use.

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Literature cited

ANDELT, W. F., R. L. PHILLIPS, R. H. SCHMIDT, AND R. B. GILL. 1999. Trapping furbearers: an overview of the biological and social issues surrounding a public policy controversy. Wildlife Society Bulletin 27:53-64.

COCKRELL, S. 1999. Crusader activists and the 1996 Colorado anti-trapping campaign. Wildlife Society Bulletin 27:65-74.

ENGEMAN, R. M., H. W. KRUPA, AND J. KERN. 1997. On the use of injury scores for judging the acceptability of restraining traps. Journal of Wildlife Research 2:124-127.

GRUVER, K. S., R. L. PHILLIPS, AND E. S. WILLIAMS. 1996. Leg injuries to coyotes captured in standard and modified Soft Catch© traps. Proceedings of the Vertebrate Pest Conference 17:91-93.

HUBERT, G. F., JR., L. L. HUNGERFORD, AND R. D. BLUETT. 1997. Injuries to coyotes captured in modified foothold traps. Wildlife Society Bulletin 25:858-863.

HOUBEN, J. M., M. HOLLAND, S. W. JACK, AND C. R. BOYLE. 1993. An evaluation of laminated offset jawed traps for reducing injuries to coyotes. Proceedings of the Great Plains Wildlife Damage Control Workshop 11:148-153.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION. TC191 1999. Animal (mammal) traps-Part 5: Methods for testing restraining traps. International Standard ISO/DIS 10990-5. International Organization for Standardization, Geneva, Switzerland.

LINHART, S. B., AND G. J. DASCH. 1992. Improved performance of padded jaw traps for capturing coyotes. Wildlife Society Bulletin 20:63-66.

ONDERKA, D. K., D. L. SKINNER, AND A. W. TODD. 1990. Injuries to coyotes and other species caused by four models of foothold devices. Wildlife Society Bulletin 18:175-182.

PHILLIPS, R. L. 1996. Evaluation of three types of snares for capturing coyotes. Wildlife Society Bulletin 24:107-110.

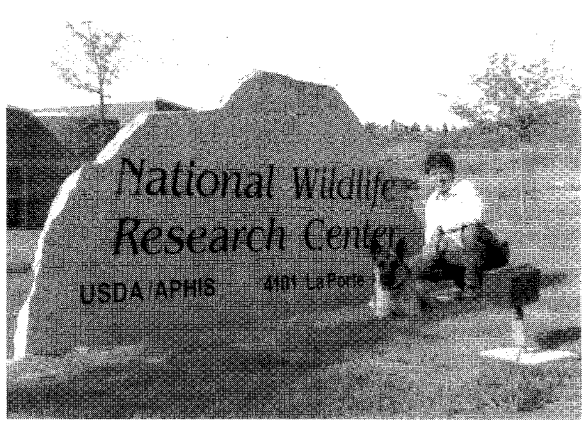
PHILLIPS, R. L., F. S. BLOM, G. J. DASCH, AND J. W. GUTHRIE. 1992. Field evaluation of three types of coyote traps. Proceedings of the Vertebrate Pest Conference 15:393-395.

PHILLIPS, R. L., AND C. L. MULLIS. 1996. Expanded field testing of the No. 3 Victor Soft Catch Trap. Wildlife Society Bulletin 24:128-131.

PHILLIPS, R. L., K. S. GRUVER, AND E. S. WILLIAMS. 1996. Leg injuries to coyotes captured in three types of foothold traps. Wildlife Society Bulletin. 24:260-263.

SKINNER, D. L, AND A. W. TODD. 1990. Evaluating efficiency of footholding devices for coyote capture. Wildlife Society Bulletin 18:166-175.

UNITED STATES OF AMERICA-EUROPEAN COMMUNITY. 1997. Agreed minute and annex: Standards for the humane trapping of specified terrestrial and semi-aquatic mammals. Brussels, Belgium.



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